

Airborne PM10/PM2.5 and Heavy Metal Monitoring

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Outline

- Background
- Relevance to Future Needs of Shipyards
- UNO Student Thesis Work: A Case Study of French Quarter / Historic District
- Summary



Background

- Ambient PM10 and PM2.5 are regulated pollutants that have National Ambient Air Quality Standards (NAAQS)
- Others criteria pollutants: SO₂, NO_x, O₃, CO, Pb
- Ambient concentration of heavy metals are not part of NAAQS (not criteria) but are important from the residual risk point of view (they are regulated under HAPs)



Relevance to Future Needs of the Shipbuilding Sector

- Goals of all environmental regulations are to minimize health and environmental impacts
- Heavy metals drive the inhalation based risk due to associated high toxicity
- EPA's recent focus on "health risks" from airborne contaminants from shipyards and other industry sectors



**Case Study:
Assessment of Ambient
PM₁₀/PM_{2.5} and Heavy Metals in
New Orleans Historic District**



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Louisiana Ambient Air Monitoring Program

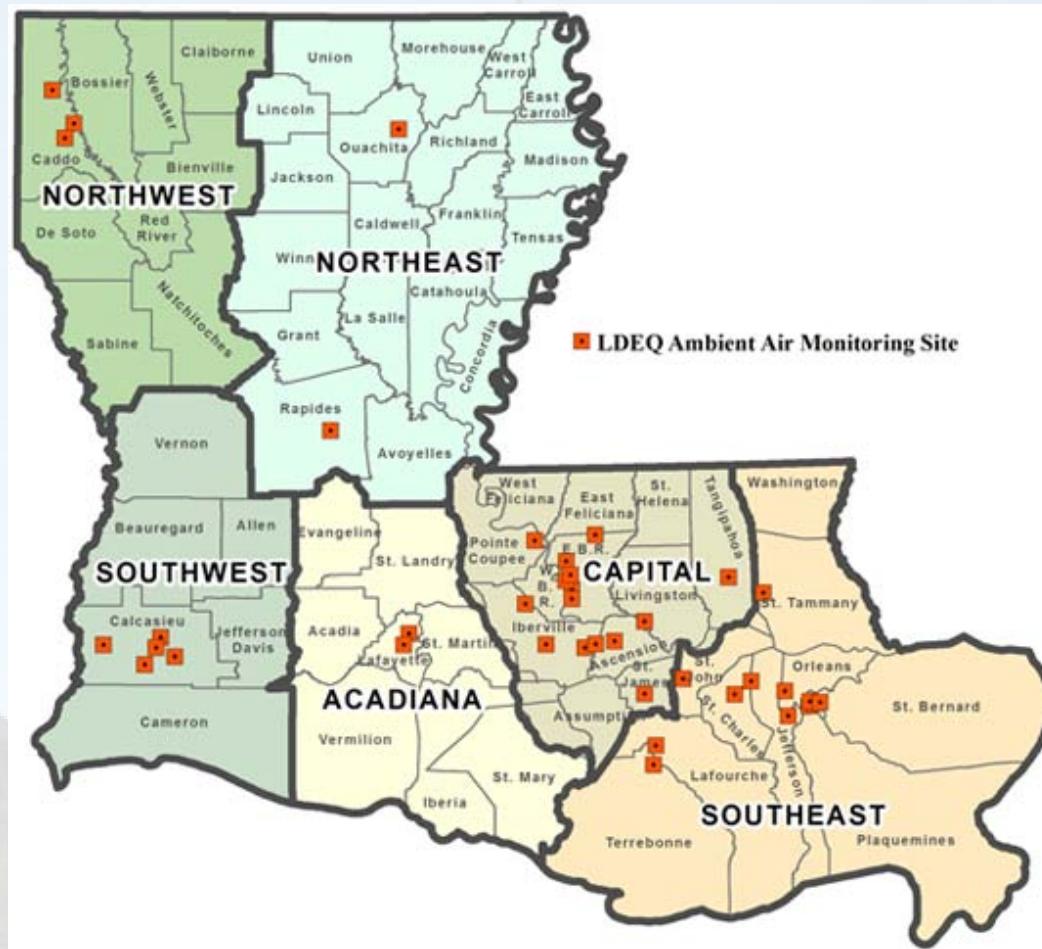


Image courtesy of LDEQ: www.deq.louisiana.gov



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LDEQ Monitoring Stations in the Greater New Orleans

| Sampling Site | Address | Distance from the St. Luis Cathedral | Monitoring PM _{2.5/10} |
|-----------------------|--|--------------------------------------|---------------------------------|
| Algiers Entergy | 2456 Ernest. New Orleans, LA | 5.5 miles | |
| Chalmette High School | 1100 E Jorge Perez Drive. Chalmette, LA | 6.7 miles | |
| Chalmette Vista | 24 E. Chalmette Circle. Chalmette, LA | 5.4 miles | Yes |
| City Park | Florida & Orleans Avenue, New Orleans, LA | 3.3 miles | Yes |
| Kenner | 100 West Temple Place, Kenner, LA | 13.8 miles | Yes |
| Marrero | Patriot Street and Allo Street. Marrero, LA | 5.4 miles | Yes |
| Meraux | 4101 Mistrot Drive. Meraux, LA | 8.5 miles | |



Sampling Site Location

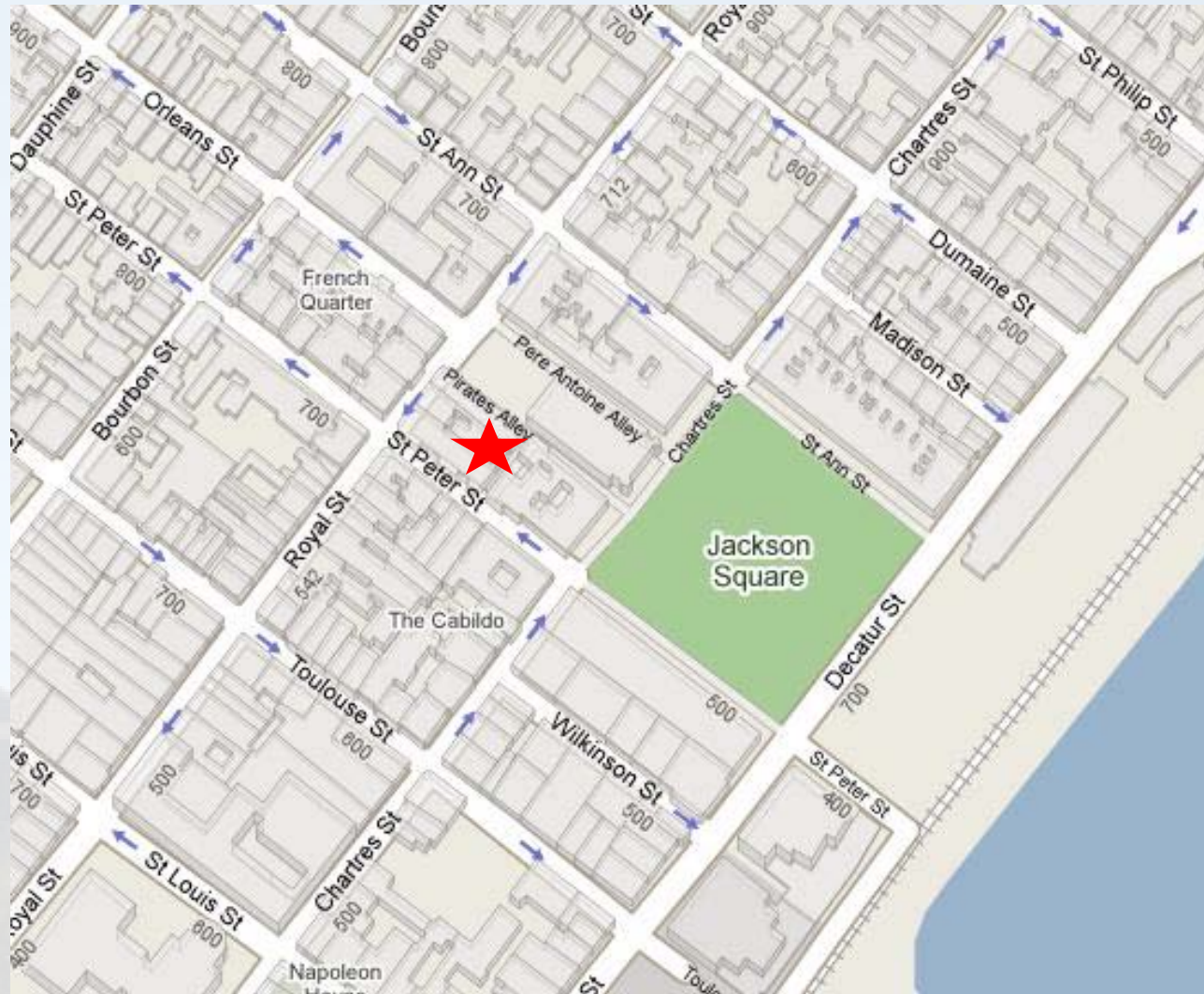
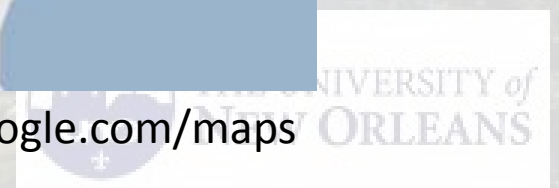


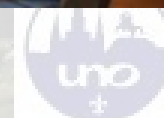
Image courtesy of Google maps: www.maps.google.com/maps



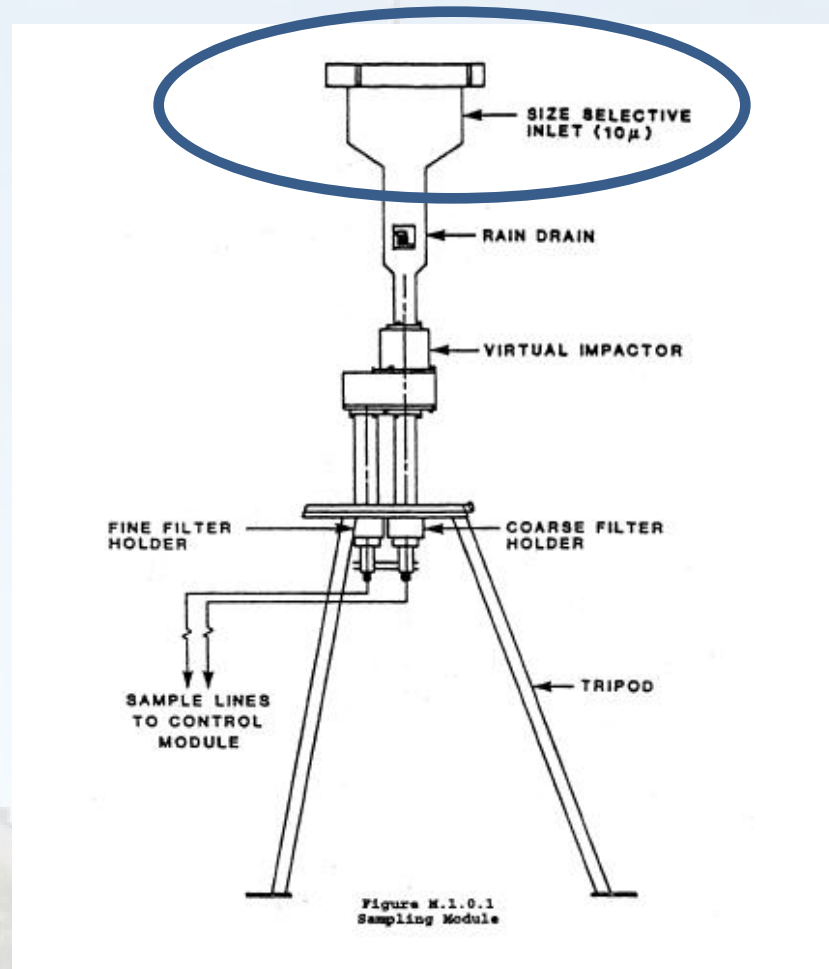
PM10/PM2.5 Sampler



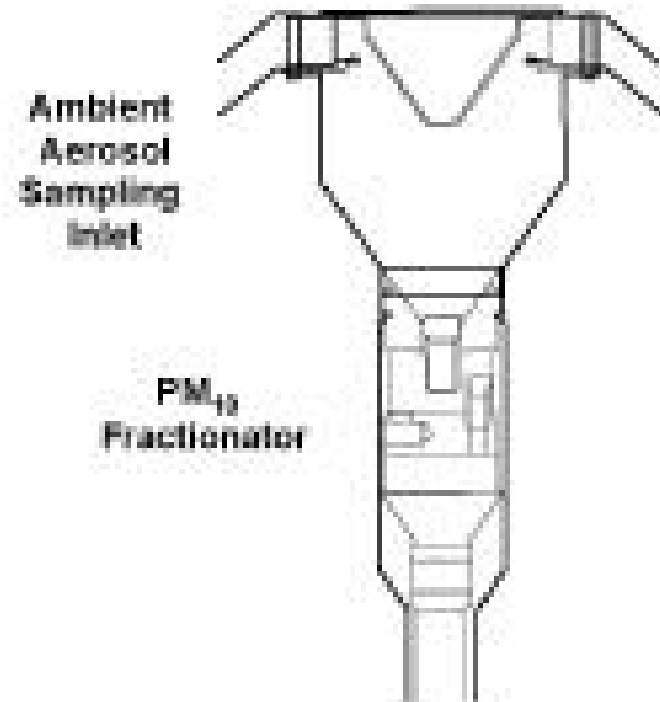
Anderson Dichotomous Sampler



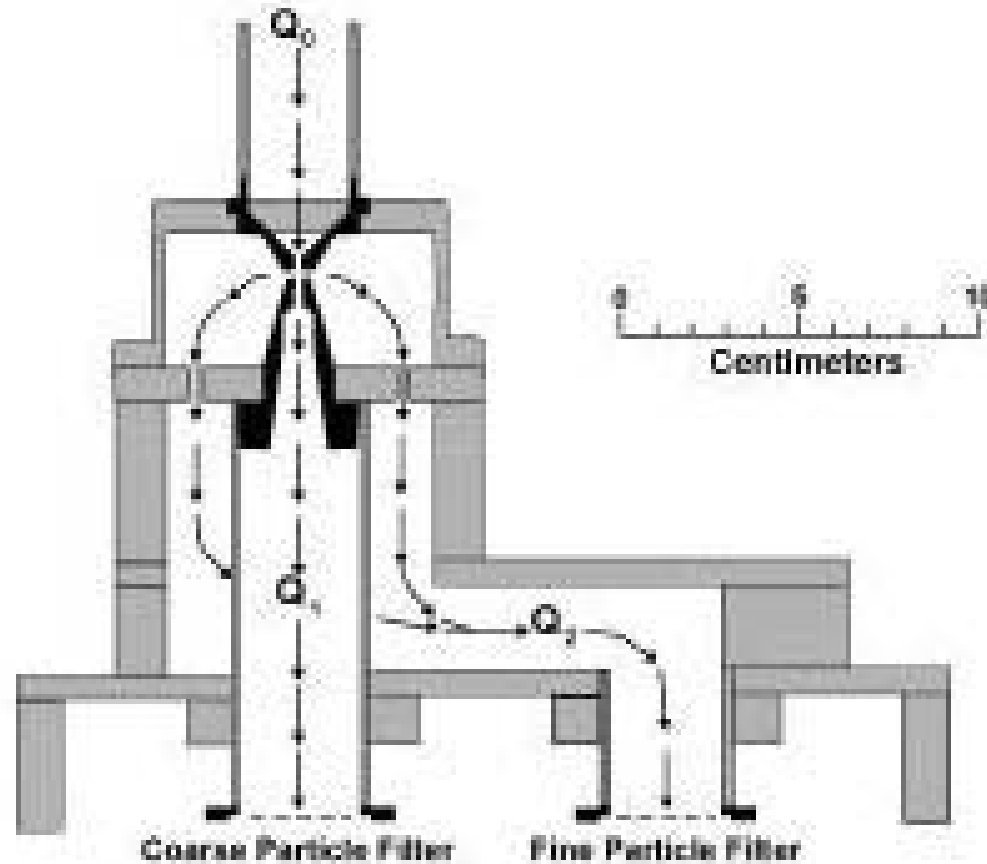
Dichotomous: Principle of Operations



Dichotomous Principle of Operations



Dichotomous Principle of Operations



Filter in the Dichotomous

- 37mm Teflon
 - Fine Particles: Diameter $2.5 \mu\text{m}$ or smaller
 - Coarse Particle: Diameter 2.5 to $10 \mu\text{m}$



Calibration of the Dichotomous Sampler

- **Dry Gas Meter:**

- Calibration Transfer Standard
- DC-2 Flow Calibrator
- Dry Cal/Bios International s/n B833
- Certified with EPA equipment Dry Cal s/n 107565

- **Flow Mete:**

- Streamline Pro™ Multical™ System
- Model M: 0.9 to 19.0 L/min
- NIST Traceable Standards
- Fabricator: Chinook Engineering

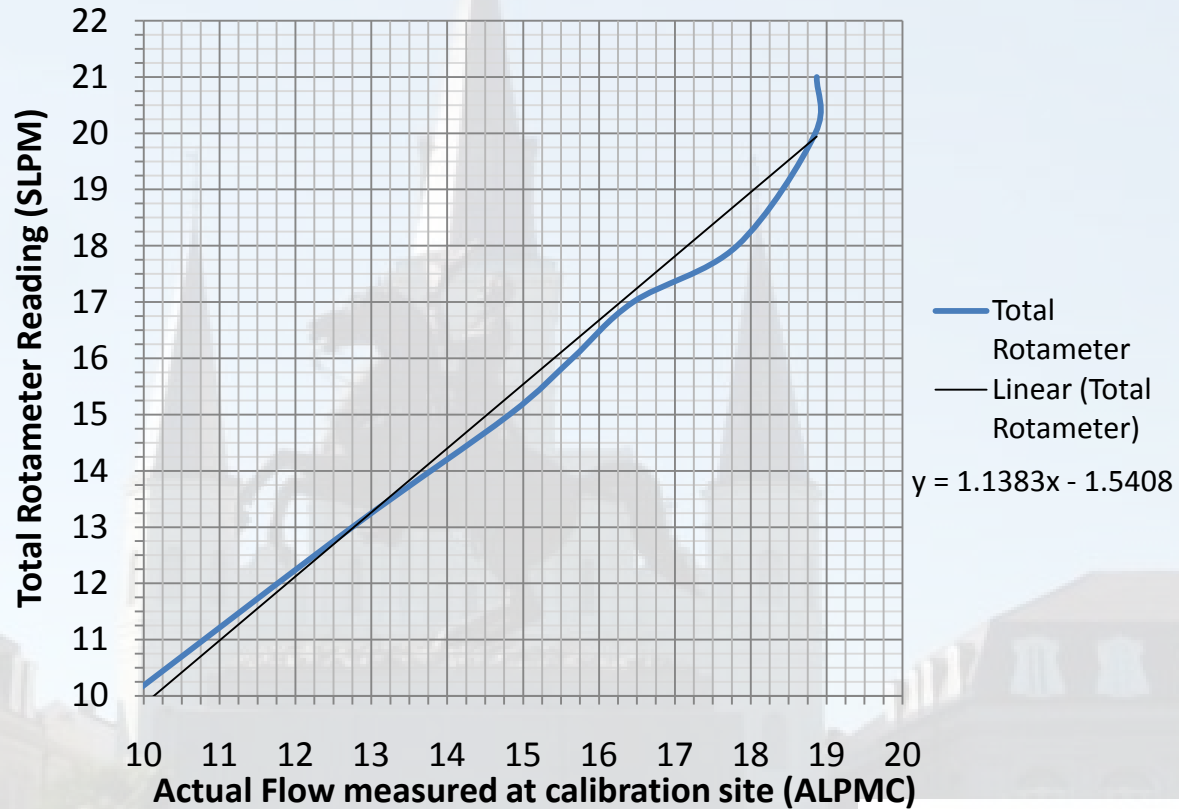
Calibration of the Dichotomous Sampler



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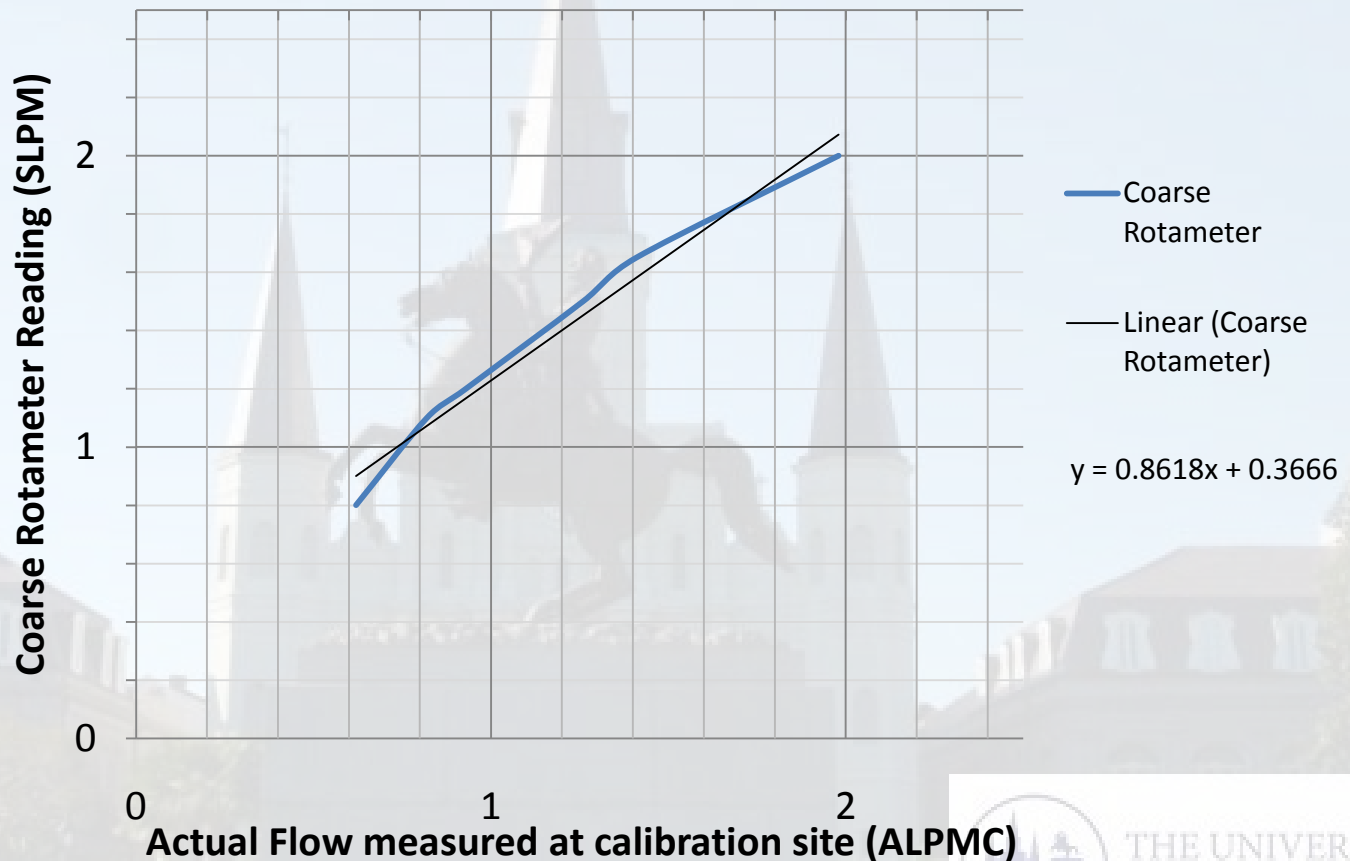
Rotameter Calibration

Actual Rotameter Calibration Conditions:
T=18.8°C , P= 1.0006 atm



Rotameter Calibration

Actual Rotameter Calibration Conditions:
T=18.8°C , P= 1.0006 atm



Flow Correction for Temperature and Pressure

Total Flow 16.7 L/min
Coarse Flow 1.67 L/min

At sampling point T and P

Correct to Calibrations conditions
of T and P with

$$Q_c = Q_s \times \frac{T_c}{T_s} \times \frac{P_s}{P_c}$$

Use Calibration Data to fix
flow at correct Rotameter
reading



Gravimetric Analysis

Experiment 1 10/27-28/08 : 28hrs

| Filter # | Weight Clean Filer (g) | Ring | Particles size | Weight PM + Filer (g) | Start Collection time 10/27/08 | End Collection time 10/28/08 | Sampling time (min) | Volume of Air Sampled (m ³) |
|----------|------------------------|--------|----------------|-----------------------|--------------------------------|------------------------------|---------------------|---|
| 1 | 0.1234 | yellow | coarse | 0.1239 | 12:00 n | 4:00pm | 1680 | 2.81 |
| 2 | 0.1230 | white | fine | 0.1232 | 12:00 n | 4:00pm | 1680 | 25.20 |

Experiment 3 10/29-31/08 : 46hrs

| Filter # | Weight Clean Filer (g) | Ring | Particles size | Weight PM + Filer (g) | Start Collection time 10/27/08 | End Collection time 10/28/08 | Sampling time (min) | Volume of Air Sampled (m ³) |
|----------|------------------------|--------|----------------|-----------------------|--------------------------------|------------------------------|---------------------|---|
| Y7 | 0.1223 | yellow | coarse | 0.1227 | 4:00pm | 2:00pm | 2760 | 4.61 |
| W8 | 0.1221 | white | fine | 0.1224 | 4:00pm | 2:00pm | 2760 | 41.40 |



Gravimetric Analysis

| Exp # | Collection Time (hrs) | Ambient Air PM ($\mu\text{g}/\text{m}^3$) | |
|-----------|--------------------------|--|-------|
| | | PM10 | PM2.5 |
| 1 | 24 | 25.00 | 7.94 |
| 2 | 24 | 12.50 | 4.63 |
| 3 | 48 | 15.21 | 7.25 |
| 4 | 48 | 10.20 | 11.34 |
| 5 | 48 | 12.50 | 4.63 |
| Average | | 15.08 | 7.16 |
| EPA NAAQS | | 150 | 35 |

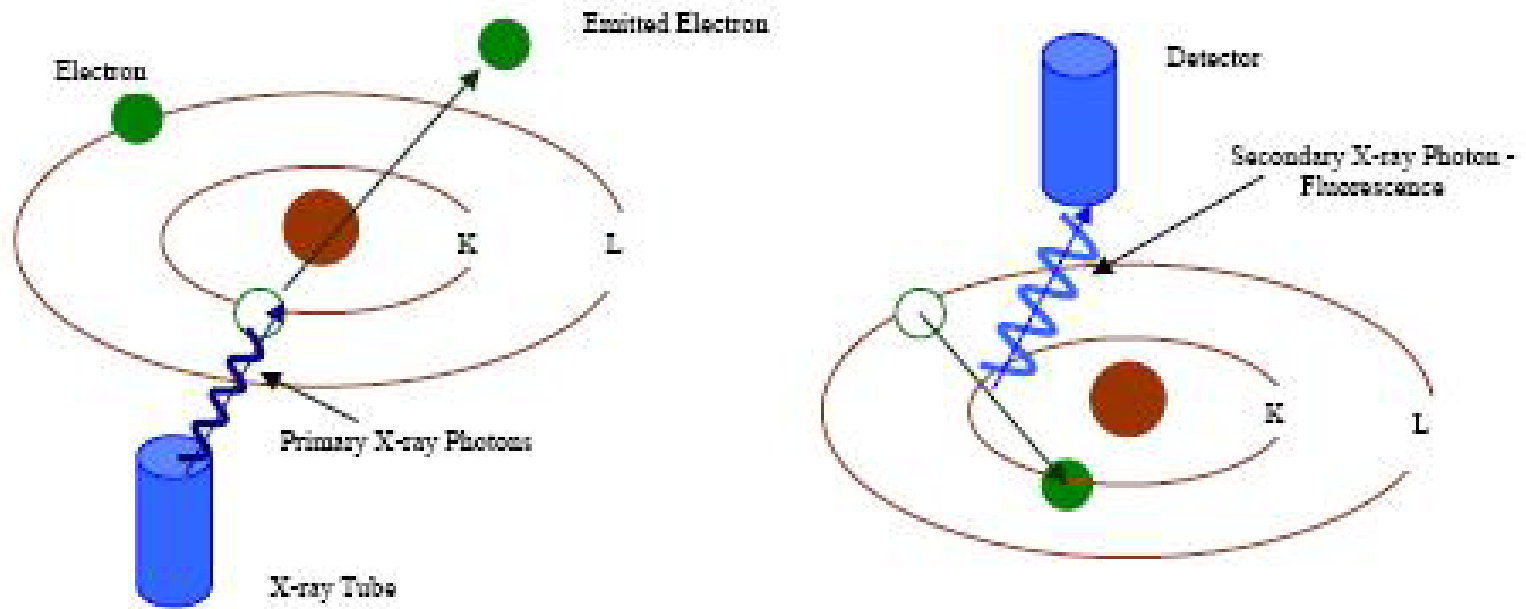


X-R Fluorescence Analysis

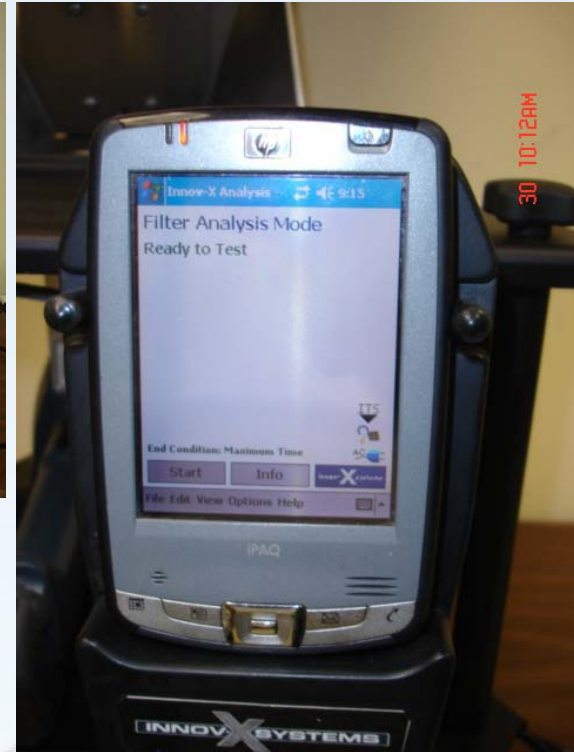
- Innov-X Model Alpha 6500 s/n 5660
- Innov-X Model XT-442L s/n 1001



XRF: Principle of Operation



X-Ray Analysis



Experimental Data

- PM from the Dichotomous Sampler
- Metal concentration from the XRF



PM Concentration Ambient Air

| PM size | Concentration |
|---------|--------------------------------|
| PM2.5 | 7.16 $\mu\text{g}/\text{m}^3$ |
| PM10 | 15.08 $\mu\text{g}/\text{m}^3$ |



National Ambient Air Quality Standard

| Pollutant | Average Time | Primary Standard | Secondary Standard |
|-------------------|------------------------|-----------------------|--------------------|
| SO ₂ | Annual arithmetic mean | 0.03 ppm | |
| | 24 hrs average | 0.14 ppm | |
| | 3 hrs average | | 0.50 ppm |
| NO ₂ | Annual arithmetic mean | 0.053 ppm | Same as primary |
| CO | 1 hrs average | 35 ppm | |
| PM ₁₀ | Annual arithmetic mean | | (*1) |
| | 24 hrs average | 150 µm/m ³ | (*2) |
| PM _{2.5} | Annual arithmetic mean | 15 µm/m ³ | (*3) |
| | 24 hrs average | 35 µm/m ³ | (*4) |
| O ₃ | 1 hrs average | 0.12 ppm | Same as primary |
| | 8 hr Maximum | 0.085 ppm | Same as primary |
| Lead | Quarterly Average | 1.5 µm/m ³ | Same as primary |

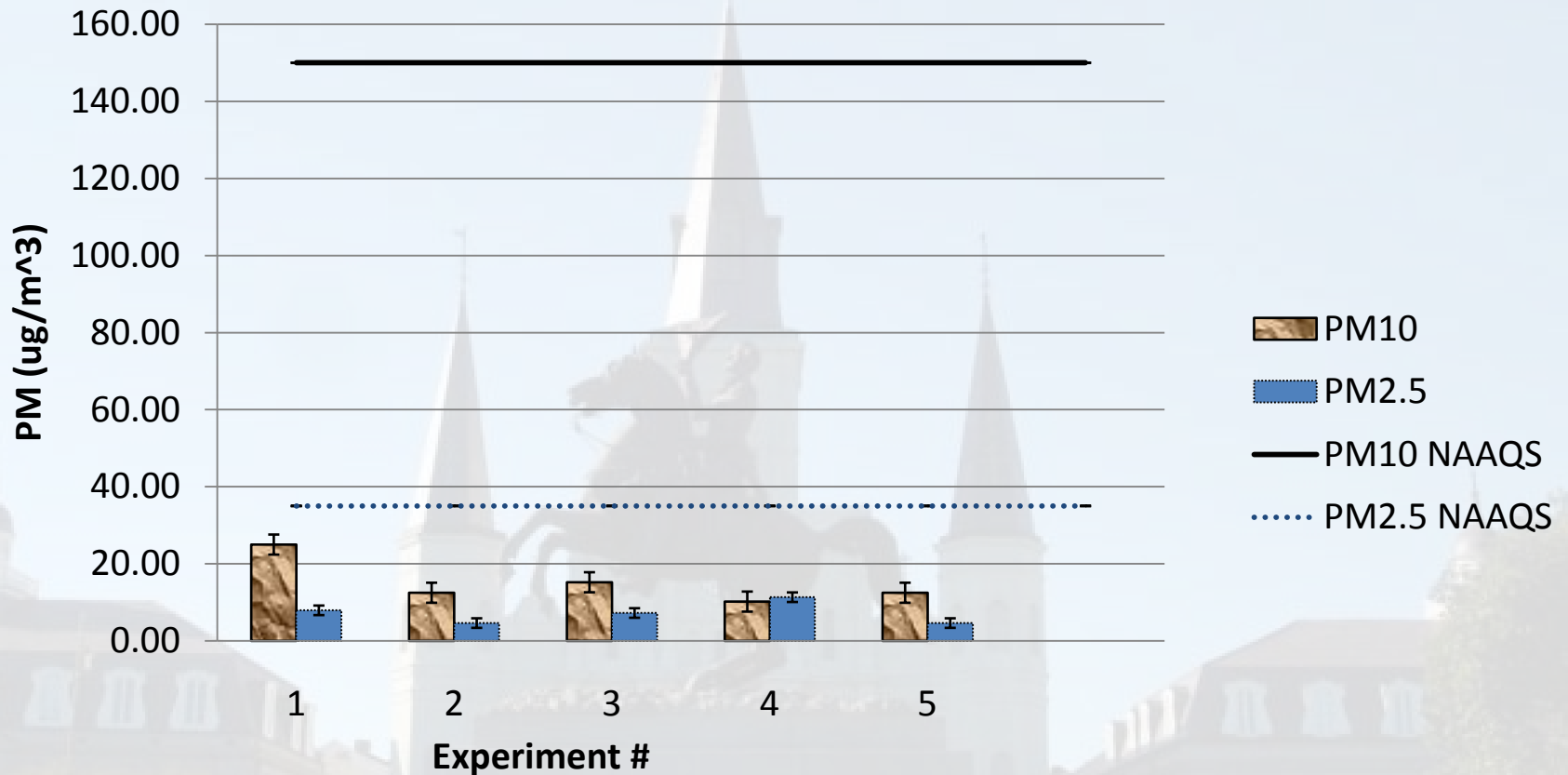
Notes: (*1) The Annual NAAQS for PM₁₀ had not been set by EPA yet. Before December 2006, it was 50µm/m³

(*2) Not to be exceeded more than once per year on average over 3 years

(*3) To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m³

(*4) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m³ (effective December 17, 2006)

Particulate Matter in the Ambient Air of the New Orleans Historic District with their Corresponding NAAQS



Air Quality Index

| I Value | PM ₁₀ 24-hrs Ave (µg/m ³) | PM _{2.5} 24-hrs Ave (µg/m ³) | SO ₂ 24-hrs Ave (ppm) | NO ₂ 24-hrs Ave (ppm) | CO 24-hrs Ave (ppm) | O ₃ 1-hr (ppm) | O ₃ 8-hr (ppm) |
|---------|--|--|---|---|------------------------------|---------------------------------|---------------------------------|
| 0 | 0 | 0 | 0 | N/A | 0 | N/A | 0 |
| 50 | 55 | 15.5 | 0.035 | N/A | 4.5 | N/A | 0.060 |
| 100 | 155 | 40.5 | 0.145 | N/A | 9.5 | 0.125 | 0.076 |
| 200 | 255 | 65.5 | 0.225 | N/A | 12.5 | 0.165 | 0.096 |
| 300 | 355 | 150.5 | 0.305 | 0.65 | 15.5 | 0.205 | 0.116 |
| 400 | 425 | 250.5 | 0.605 | 1.25 | 30.5 | 0.405 | N/A |
| 500 | 505 | 305.5 | 0.805 | 1.65 | 40.5 | 0.505 | N/A |

N/A= Values bellow threshold limit; do Not Apply standardization.



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Air Quality Index

| I Value | PM ₁₀ 24-hrs Ave (µg/m ³) | PM _{2.5} 24-hrs Ave (µg/m ³) |
|---------|--|--|
| 0 | 0 | 0 |
| 50 | 55 | 15.5 |
| 100 | 155 | 40.5 |
| 200 | 255 | 65.5 |
| 300 | 355 | 150.5 |
| 400 | 425 | 250.5 |
| 500 | 505 | 305.5 |

For PM₁₀ = 15.08 µg/m³

Interpolating for "I" from 0 to 50
and PM₁₀ for 0 to 55.

$$I = \frac{50}{55} \times (15.08 - 55) + 50 = 13.71$$

For PM_{2.5} = 7.16 µg/m³

Interpolating for "I" from 0 to 50
and PM_{2.5} for 0 to 15.5

$$I = \frac{50}{15.5} \times (7.16 - 15.5) + 50 = 23.10$$



Air Quality Index

| Parameter | AQI |
|-----------|-------|
| PM2.5 | 23.10 |
| PM10 | 13.71 |



Description of Ambient Air based in AQI

| AQI Value | Air Quality Description |
|-----------|-------------------------|
| 0 – 50 | Good |
| 51 – 100 | Moderate |
| 101 – 200 | Unhealthful |
| 201 – 300 | Very Unhealthful |
| ≥ 301 | Hazardous |

For AQI= 23.10 The Ambient Air is defined as of “Good” quality in the sampling site

Metal Concentration

| | (ug Metal/cm ²) | | (ug Metal/filter) | | Mass fraction (Metal/PM) | | Concentration |
|-----------|-----------------------------|----------|-------------------|----------|-----------------------------|----------|------------------------------------|
| | PM2.5 | PM2.5-10 | PM2.5 | PM2.5-10 | PM2.5 | PM10 | (ug Metal / m ³ air) |
| | | | | | | | |
| Cr | 0.73 | 0.73 | 0.08 | 0.08 | 2.53E-04 | 2.54E-04 | 3.26E-03 |
| Fe | 1.18 | 2.55 | 0.13 | 0.27 | 4.10E-04 | 8.86E-04 | 8.34E-03 |
| Ni | 0.04 | 0.03 | 4.30E-03 | 3.23E-03 | 1.39E-05 | 1.04E-05 | 1.56E-04 |



Conclusions

- PM_{2.5} at 25 feet above street level in the New Orleans French Quarter showed to be 7.16 $\mu\text{g}/\text{m}^3$
- PM₁₀ at 25 feet above street level in the New Orleans French Quarter showed to be 15.08 $\mu\text{g}/\text{m}^3$
- Ambient Air of the New Orleans Historic District can be categorized as “Good” based on EPA’s AQI criteria



Conclusions

- Heavy metal concentration in the ambient air of sampling site is calculated and reported
 - Metal fraction (Select Metal / PM10 or PM2.5)
 - Metal concentration (mass / air volume)
- This information can be used to calculate probability of health risks to the community



Conclusions

- Relevance to shipyards (or any other source or sector):
 - Background (a) concentrations and (b) health risks from metals (cancer and non-cancer)
 - Net increase due to individual facility in (c) ambient concentration and (d) health risks
- Often eliminates the errors involved in modeling assumptions as these are actual measurements

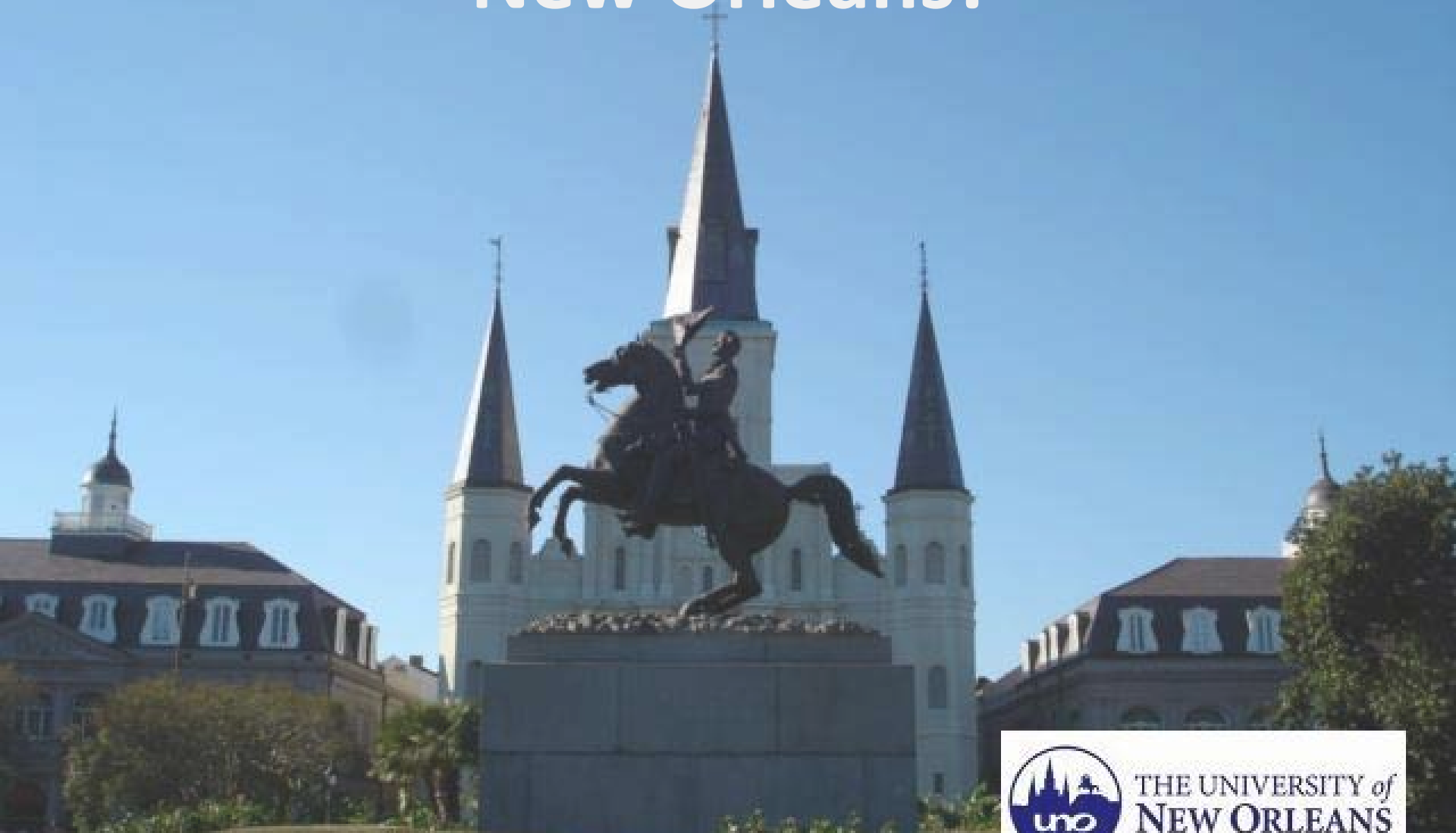


UNO's Resources for Collaboration

- The Andersen Dichotomous Sampler Model 240 is fully operative at UNO and ready to help support future shipyard research
- XRF Analyzer Model XL-442L is also available for use in future research
- Emissions Test Facility and others are being upgraded with the FEMA money (after Katrina damaged facilities) which should be available for future research



Thank you and enjoy your time in
New Orleans!



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